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This is a trial edition of this unit. Your comments on its suitability and suggestions for its improvement will be appreciated.

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Reiner Specht,
Kip Anastasiou,
October, 1977.

Children love trees. They use them for a multitude of games from hide-'n'-seek to building tree forts. Swings of all kinds can be attached to the branches of backyard trees. On hot summer days the cool shade of trees can be enjoyed. In fall they love to plough through the masses of leaves on the sidewalk or to jump into great mounds of leaves which have been raked together. At Christmas, under the tree decorated with lights and ornaments, children find their gifts.

This unit is designed to add a further dimension to the interaction of children and trees. It provides a large number of activities through which children can develop a comprehensive understanding of trees and their interactions with the plants and animals in their environment.

Studying trees, whether in the forest or on a city boulevard, can be a very exciting and rewarding experience for children and their teachers. The activities which follow will provide a rich series of experiences leading to an in-depth understanding of many aspects of tree ecology, measurement, anatomy, growth behaviour and an introduction to the classification of trees.

Since most of the activities focus on the study of trees in the out-of-doors, teachers should plan to utilize a treed area which is conveniently located near the school.

Previewing a possible site:

Once a site near the school has been identified the teacher should visit it and check out its suitability.

She should check:

1) to ensure that the area is easily accessible.
2) to ensure that the area is able to accommodate the number of children to be involved without damaging the environment.
3) to ensure that the area has a sufficient number of trees to provide rich activities.
4) to determine what sort of shoes and clothing will be necessary. Some treed areas are quite boggy, others flat and dry, and still others rocky and hilly. Each habitat may require special clothing or footwear.

The First Trip

The first trip to the forest should allow the students to become familiar with the forest environment and should be relatively unstructured. Let the children explore the new environment with their eyes, ears, touch, and sense of smell. Encourage them to be gentle with the forest. It houses the largest plants and the oldest living things on earth. The children should be encouraged to leave the environment as it is as much as possible. Emphasize the idea of conservation for future enjoyment. The

collecting of specimens, tearing off of leaves and branches should be strongly discouraged.

ACTIVITY 1: SENSING THE FOREST:

In this introductory activity the pupils should be encouraged to explore the forest with their senses. They should listen quietly to identify the sounds and voices of the forest. They should feel the full range of sensations provided by slimy slugs to the dry powder of puffballs. They can experience the contrasting colours of bright blue sky and the screaming red of the tiny female flowers of hazelnut against the soft greens and browns of the forest. Most of the odors of the forest are mild and "clean" smelling so children don't often notice them. Encourage them to smell a rotting log, a handful of soil or the needles of a standing tree.

The students will have learned that the forest consists of more than just trees. One can imagine the forest as a huge house. The soil is the basement, the forest floor is the ground floor, the herb and shrub layer is the 2nd floor and the canopy of the trees forms the roof.

How do these layers differ?
Do they get the same amount of light?
Is the canopy continuous or are there gaps?
How does the temperature differ?
Does one layer affect the growth of another?
How is the forest different from a field?
The next few activities should help to answer these questions.

ACTIVITY 2: MEASURING THE AMOUNT OF LIGHT:

Materials: lightmeter, pencil and field note book

The teacher should demonstrate the use of the lightmeter. Instruct the students to walk with the lightmeter from an open area such as a school yard or road into the forest and list the readings of the lightmeter.

Have the children note (in their books) the locations where changes occur rapidly. Stop at the forest edge and point the lightmeter in different directions and note the readings.

Does the direction affect the readings of the lightmeter?

Repeat this procedure in the forest! Is there any difference between the readings taken within the forest and those at the edge of the forest?

In the forest hold the lightmeter at different levels e.g. at groundlevel and 2 metres above groundlevel. How do they compare?

Do you think that lightmeter readings taken in an open area would be similar to the ones taken above the tops of the trees? Do you think that the amount of light on the forest floor and above the tree tops is the same? What other factors could influence the lightmeter readings (i.e. clouds, season, time of day)?

Are certain sections of the forest sunnier than others? Are there types of forests which are brighter than others? Do certain plant species prefer sunny or shaded areas? Do you think that light is important to plants?

ACTIVITY 3: MEASURING FOREST TEMPERATURES:

Material: thermometers, pencils, field note books

Measure and record temperatures in different locations

- --in an open field
- --in the forest
- --in the soil near the roots (if the soil is very hard make a hole with a dead branch first)
- --in a mousehole
- --in a forest stream or pond
- --at different heights in a small tree (choose a small tree which has knot holes or woodpecker holes)

Encourage the children to record temperatures in any other interesting places they think of. Some questions which could be asked are:

Is there a difference in temperature between:
an open field and a dense forest?
the roots and upper parts of the tree?

SUPPLEMENTARY ACTIVITY

How do you think that sun, wind and rain affect the temperature? Are the differences between temperatures in the forest and field smaller or greater on a sunny, cloudy or rainy day? What happens on windy days?

ACTIVITY 4: DIGGING INTO THE FOREST BASEMENT:

Materials: shovel, metre stick, pencil, field note book

Try to find an exposed soil profile, perhaps on a creek bank or roadcut. If you cannot find one, a hole can be dug to expose the soil layers.

Dig the hole at least a foot deep. Measure the depth and thickness of each soil layer and describe it's color, dampness and state of decomposition material.

Some questions to investigate:

--Is there a difference between the soil on the surface and the soil deeper down? Is the soil damp? Are some layers wetter than others? Are there insects in the soil? In which layer? Do you expect that the depth of the soil layers will be the same in all parts of the forest? In what ways? What happens to fallen trees?

Imagine what the forest would be like if all the trees just lay there where they fell without decomposing!

*For more detailed forest soil studies, see the VEEP unit: There's Dirt in the Forest, Western Education Development Group, U.B.C., 1977.

ACTIVITY 5: EXAMINING THE FOREST'S GROUND FLOOR:

Materials: metre stick, string and a few dead branches

This activity allows the children to focus their attention on a portion of the forest floor. Ensure that the children are spread out within view and then call out the command: "stop", "don't move" or "freeze". When everyone has stopped you can give the following instructions:

1. Note where your two feet are on the forest floor. Now step aside.
2. Record:
   a) What plants were you standing on?
   b) What animals were you standing on?
   c) What other materials are covering the forest floor (e.g. bare soil, rocks, paper?)
3. Did your feet leave depressions in the soil or marks on the plants? Were plants bent over? Will they be able to straighten up on their own? Mark them and check them later in the day. Allow the children a few minutes to watch quietly to see if the forest floor will return to its original state.

These observations serve as an excellent introduction to a simple plot study of the plants on the forest floor. For this activity, instruct the students to choose an area very close to a tree. An area 1 metre square should be laid out using a metre stick. Four twigs found lying on the ground can be pushed in at the corners, the perimeter can then be marked with a string around the four twigs. The following table can be filled in with data from the metre plot:

KIND OF TREES WITHIN 2m. OF PLOT	DISTANCE OF PLOT FROM EACH TREE	KINDS OF PLANTS INSIDE PLOT	NUMBER OF PLANTS OF EACH TYPE	HOW MUCH OF THE PLOT IS COVERED WITH PLANTS (3/4, 1/2, 1/4, etc.)

The children would find this activity even more exciting if they had tree identification books or keys with them.*

Once the student has surveyed the first site, have them move 4 metres from the nearest tree and set up another 1 m^2 plot. Repeat the activity using the same procedure and table.

The third site could be an open field. Children often find this very difficult because of the bewildering number of plants. They usually have difficulty distinguishing where one plant ends and another begins. Encourage them to try!

Compare the three plot tables. The following questions may help you analyze the results:

1. Which plot had the least growth? Which had the most? How would you explain this?
2. Were some plants found in all three areas? Which ones?
3. Were some plants found in only one of the plots? How would you explain their absence in the others?
4. Are there many flowering plants in the forest?
5. Are there many flowering plants in open areas?
6. Does grass grow more easily in the forest or in the open? How would you explain this?

---

*A book that would successfully satisfy the student's needs in British Columbia is: The Tree Book, Learning to Recognize Trees of British Columbia, published by and available from the B.C. Forest Service Information Division, Victoria, B. C.

With older groups, you may wish to sample for animal life using plots. Try an insect plot. You'll be surprised at how many you will find in a square metre if you look hard enough.

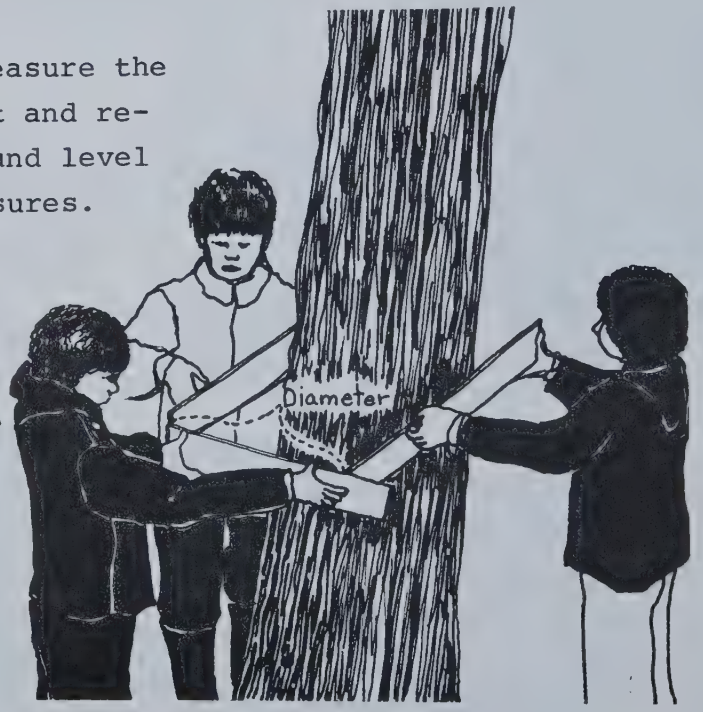
ACTIVITY 6: MEASURING THE CIRCUMFERENCE AND DIAMETER OF A TREE TRUNK:

Materials: 3 metre sticks, metric measuring tape, field note books

1. To find the circumference:

Using a metric measuring tape measure the distance around the tree at chest height and record. Measure the circumference at ground level and at 2 metres. Compare the three measures.

Distance above ground	Circumference
chest height	
ground level	
2 metres	



2. To find the diameter:

At chest height, hold two metre sticks parallel along opposite sides of the tree. Then measure the distance between the two with the third metre stick. Record the diameter.

Note: When we speak of the diameter of a tree, we are referring to its diameter at chest height (or, more properly, Diameter at Breast Height, represented by the letters D.B.H.). In forestry, since the height of people varies, the D.B.H. is declared to be 1.3 metres above the germination point of the tree.*

---

*See also the VEEP unit: Measuring the Forest, Western Education Development Group, 1975.

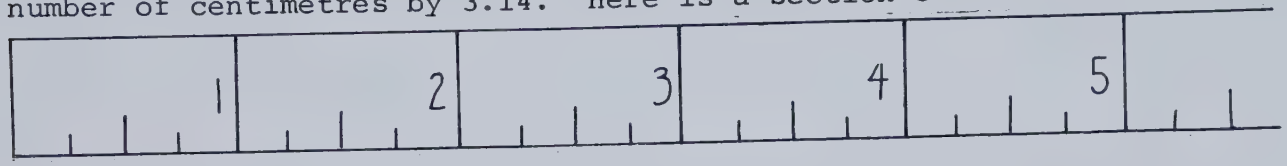
Alternative ways of determining diametre:

a. Calculating from circumference using the formula-

Diameter = circumference $\div$ 3.14

b. Using a diametre tape-

In a diametre tape each marked out centimetre has been enlarged to 3.14 cm. This allows you to read off the diametre directly without multiplying the number of centimetres by 3.14. Here is a section of a diametre tape:



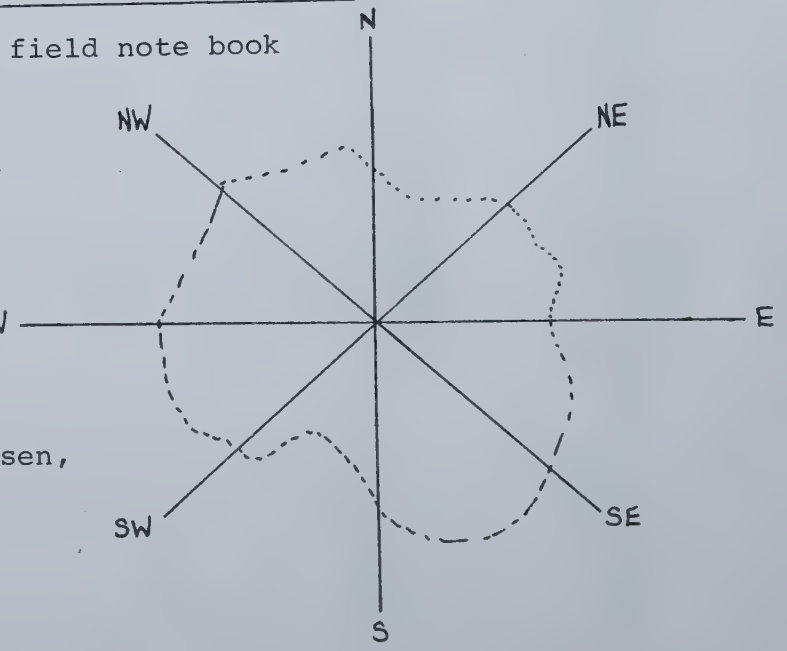
Now measure the tree at ground level and at 2m and compare the results.

Height above ground	Diameter	Circumference

ACTIVITY 7: MEASURING AND COMPARING THE SPREAD OF THE TREES' BRANCHES:

Materials: compass, tape measure, metre stick, field note book

If the students using this activity have not previously used a compass, it will be necessary for teachers to explain its use. When all students are able to read a compass have them mark a point in the centre of a page in their field note book to represent the base of the tree. Through this point they should draw lines representing the eight major compass directions. When a suitable scale has been chosen, e.g. 1 cm = 1 metre, the students are ready to begin mapping the spread of a tree's branches.



The steps in mapping are:

1. Measure the diameter of the tree and record the radius (1/2 x diameter) in your note book.
2. Stand facing out from the tree and determine the north bearing. Measure from the tree to the furthest extent of the branches on the N bearing. Record the distance.
3. Add the radius of the tree to the branch spread distance to determine branch spread from the centre of the tree.
4. Using the scale you have chosen, mark the distance on the N bearing of the tree branch spread diagram.
5. Repeat the measurements and record for each of the compass bearings.
6. When all points are recorded, they can be joined to provide a diagram of the branch spread.*

Here are some questions which can be answered using branch spread diagrams:

1. Do branches grow to the same length in all directions? If not, how could this uneven growth be explained? You might take into consideration light, winds, slope, water, etc.
2. Which species of tree has the greatest branch spread in dense forest?
3. Which species has the least spread in dense forest?
4. Which species has the greatest branch spread when grown in the open?
5. Which has the least.

---

*For further information on the use of the compass in the forest, see the VEEP unit, Measuring the Forest, Western Education Development Group, 1975.

ACTIVITY 8: FINDING THE HEIGHT OF A TREE:

The next activity deals with finding the height of a tree using a number of different methods.

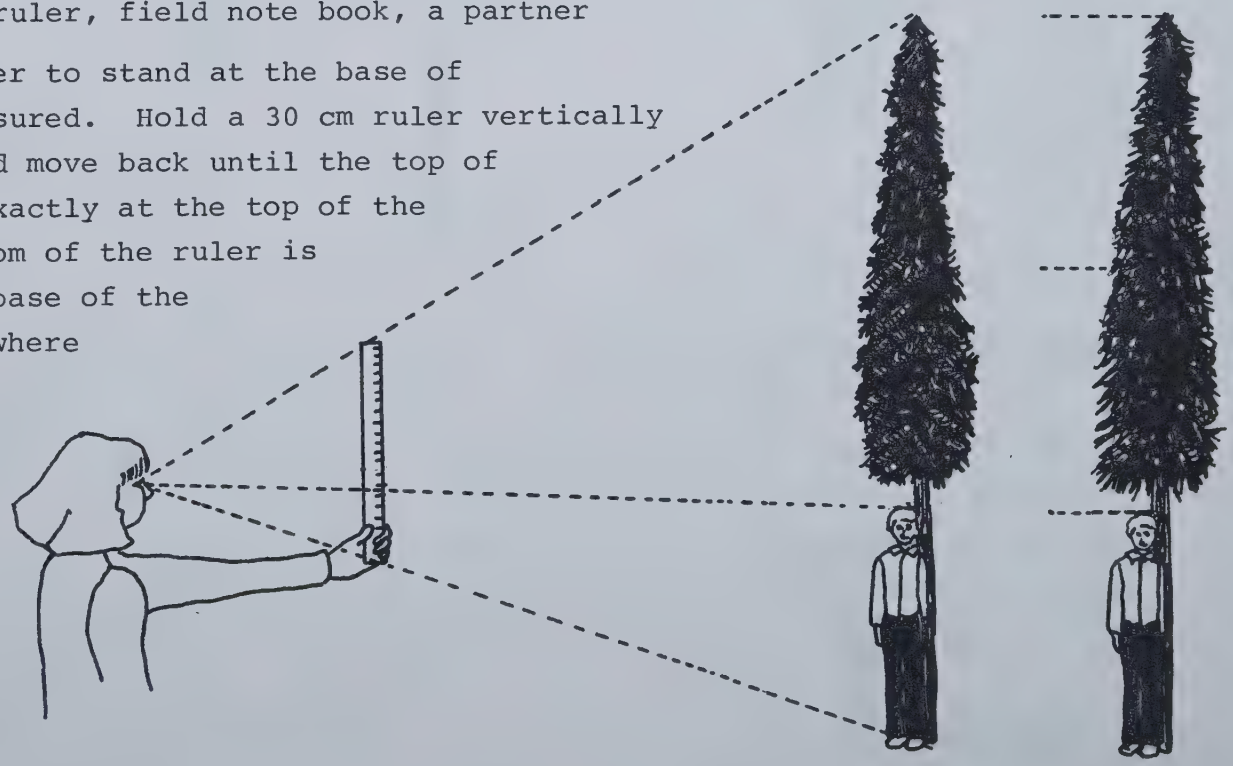
To begin, ask the children to estimate the height of a tree. Ask them also to suggest a method of determining the height of a tree. They might suggest climbing to the top of a tree pulling the measuring tape behind. Imagine climbing a Douglas-fir 70 metres tall!

Here are some methods you might try:

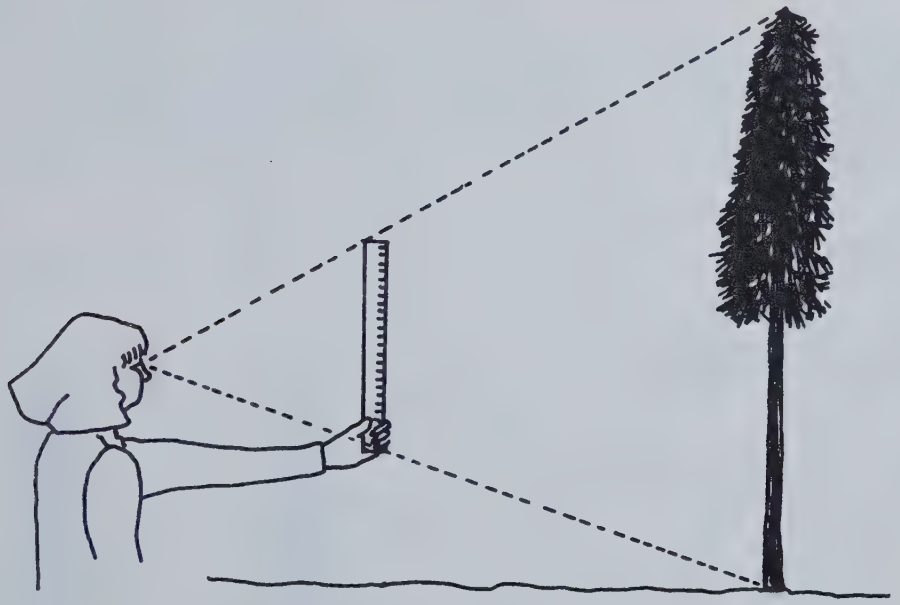
1. A PROPORTIONAL METHOD

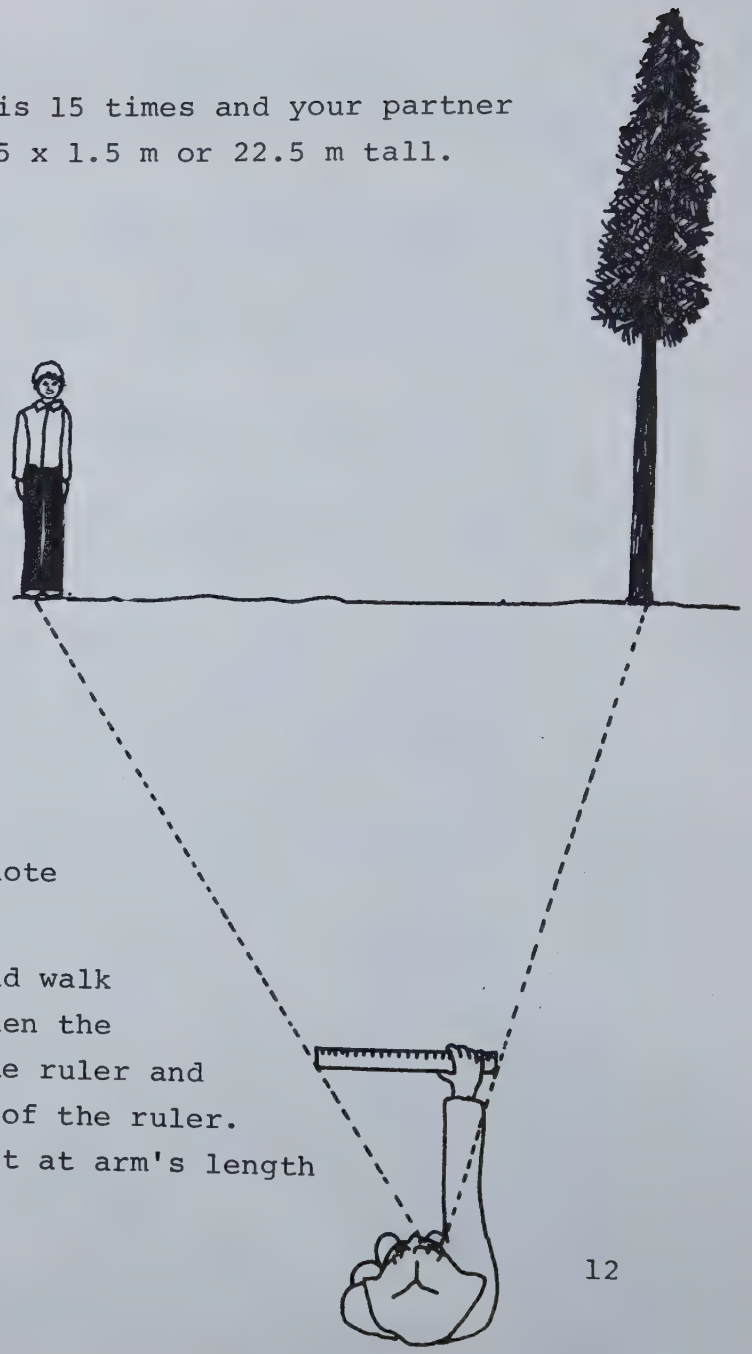
Materials: 30 cm ruler, field note book, a partner

Ask your partner to stand at the base of the tree to be measured. Hold a 30 cm ruler vertically at arm's length and move back until the top of the tree appears exactly at the top of the ruler and the bottom of the ruler is lined up with the base of the tree. Now record where the top of your partner's head appears on the ruler (e.g. the 2 cm mark) and see how many times your friend would



fit into the ruler (30 cm ÷ 2 cm = 15). If it is 15 times and your partner is 1.5 m tall, then the height of the tree is 15 x 1.5 m or 22.5 m tall.





2. RULER METHOD

Materials: 30 cm ruler, measuring tape, field note book, partner

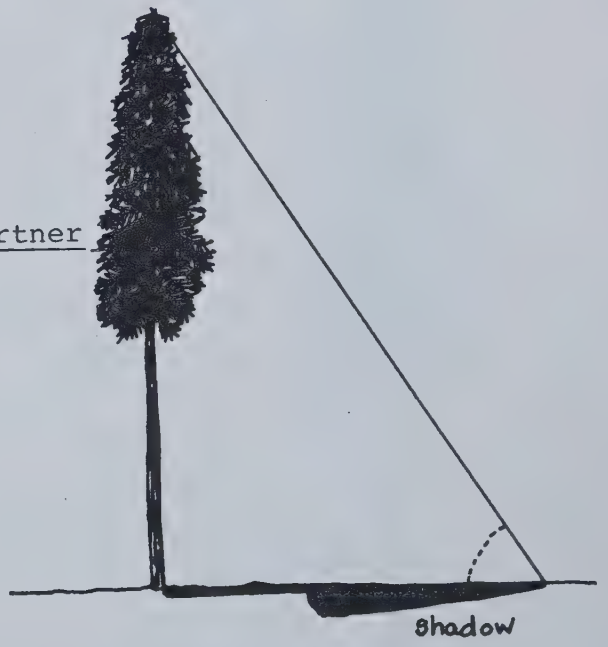
Hold the ruler vertically at arm's length and walk away from the tree you want to measure. Stop when the top of the tree appears exactly at the top of the ruler and the base appears exactly lined up with the base of the ruler. Now tip the ruler horizontally, but still hold it at arm's length

so that the bottom of the ruler is still lined up exactly with the base of the tree. Have your partner walk from the tree in the direction of the other end of the ruler. When he is lined up with the end of the ruler, the distance to the base of the tree is equal to the height of the tree.

3. SHADOW METHOD (for a sunny day)

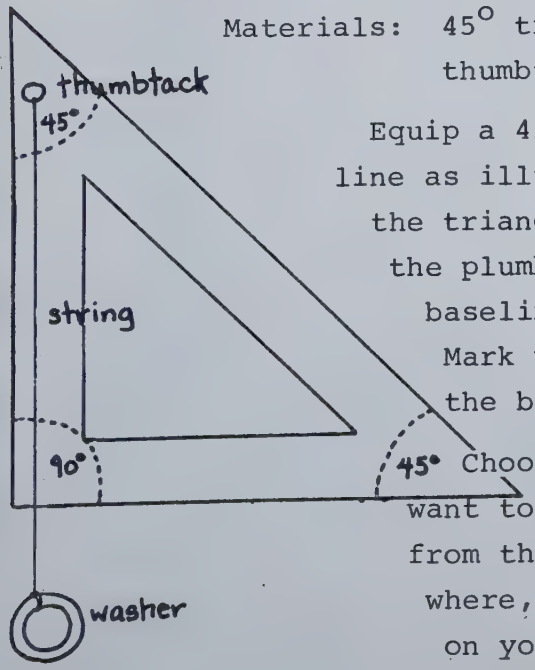
Materials: measuring tape, field note book, partner
Measure the height of your partner. Then find the length of his shadow and the length of the shadow of the tree. Now you can calculate the height of the tree by using the following formula:

$$\text{Height of tree} = \frac{\text{Length of shadow of tree} \times \text{Height of your partner}}{\text{Length of shadow of partner}}$$



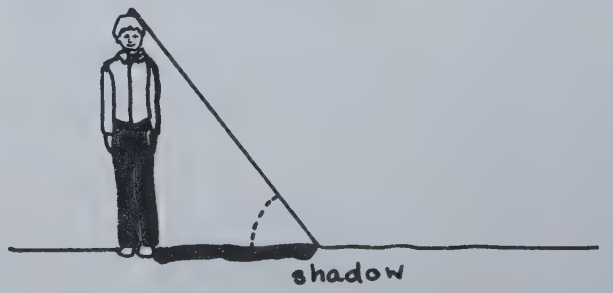
4. 45° METHOD

Materials: 45° triangle, washer, string, thumbtack, measuring tape

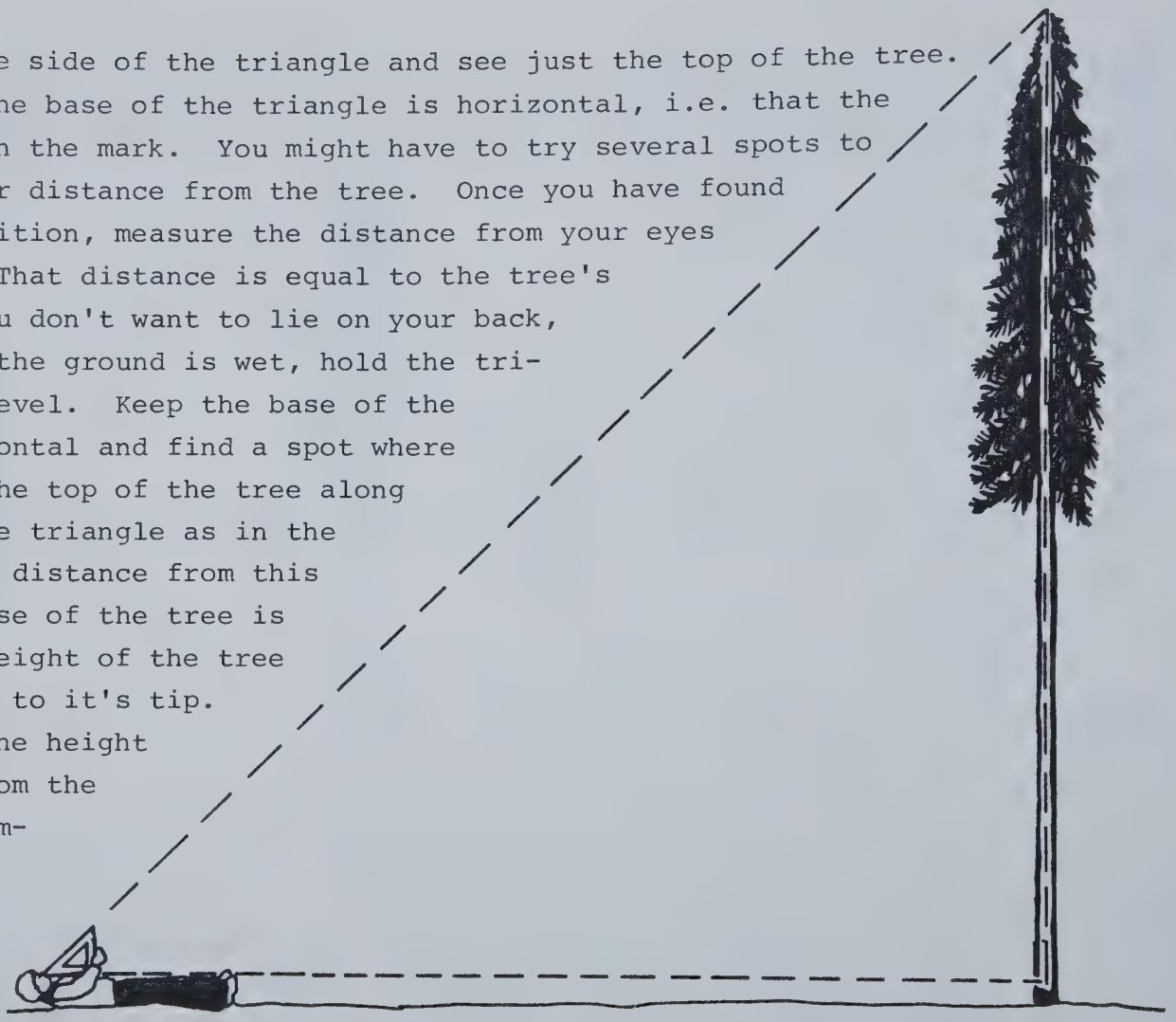


Equip a 45° triangle with a plumbline as illustrated. If the base of the triangle is held horizontally, the plumbline will cross the baseline at right angles. Mark where it crosses the base with a pencil.

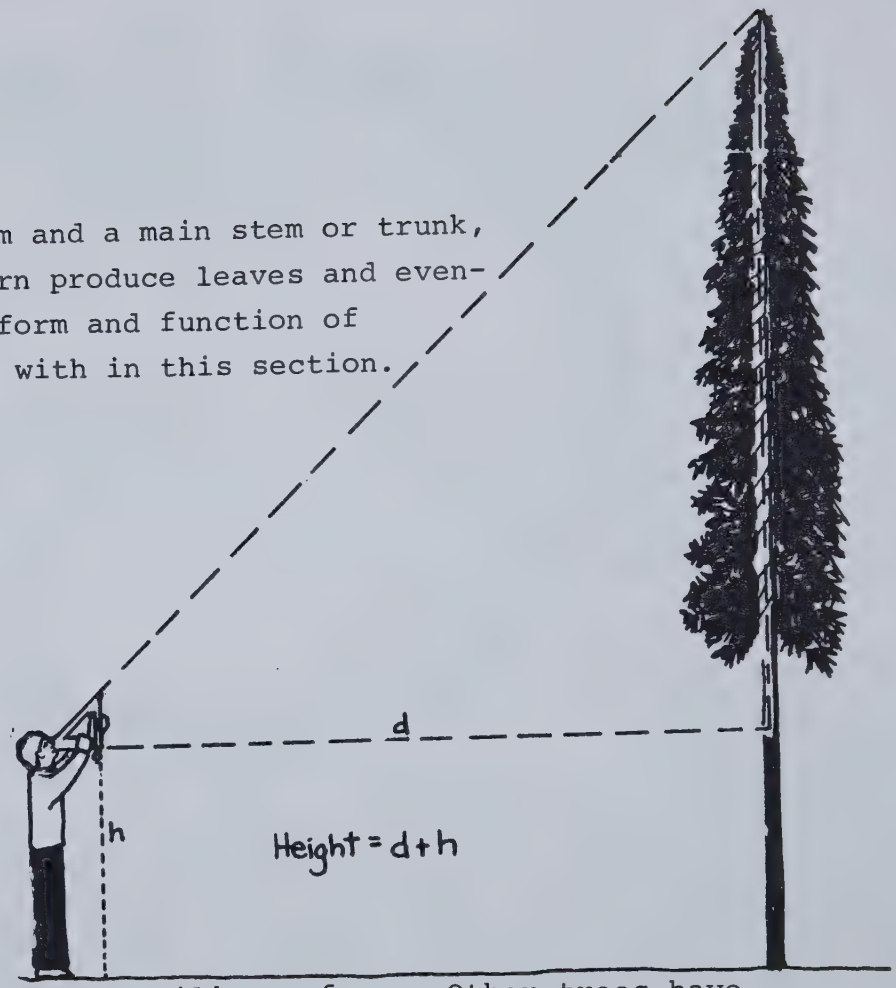
Choose the tree you want to measure. Move away from the tree and find a spot, where, when you are lying on your back, on the ground, you can



sight along the side of the triangle and see just the top of the tree. Be sure that the base of the triangle is horizontal, i.e. that the plumbline is on the mark. You might have to try several spots to find the proper distance from the tree. Once you have found the proper position, measure the distance from your eyes to the tree. That distance is equal to the tree's height. If you don't want to lie on your back, especially if the ground is wet, hold the triangle at eye level. Keep the base of the triangle horizontal and find a spot where you just see the top of the tree along the edge of the triangle as in the diagram. The distance from this spot to the base of the tree is equal to the height of the tree from your eyes to it's tip. To determine the height of the tree from the ground, you simply add the distance from your eyes to the ground. In the accompanying diagram, d is the distance from the student to the tree, and h is the height to the eyes of the student. The height of the tree



is equal to d + h.



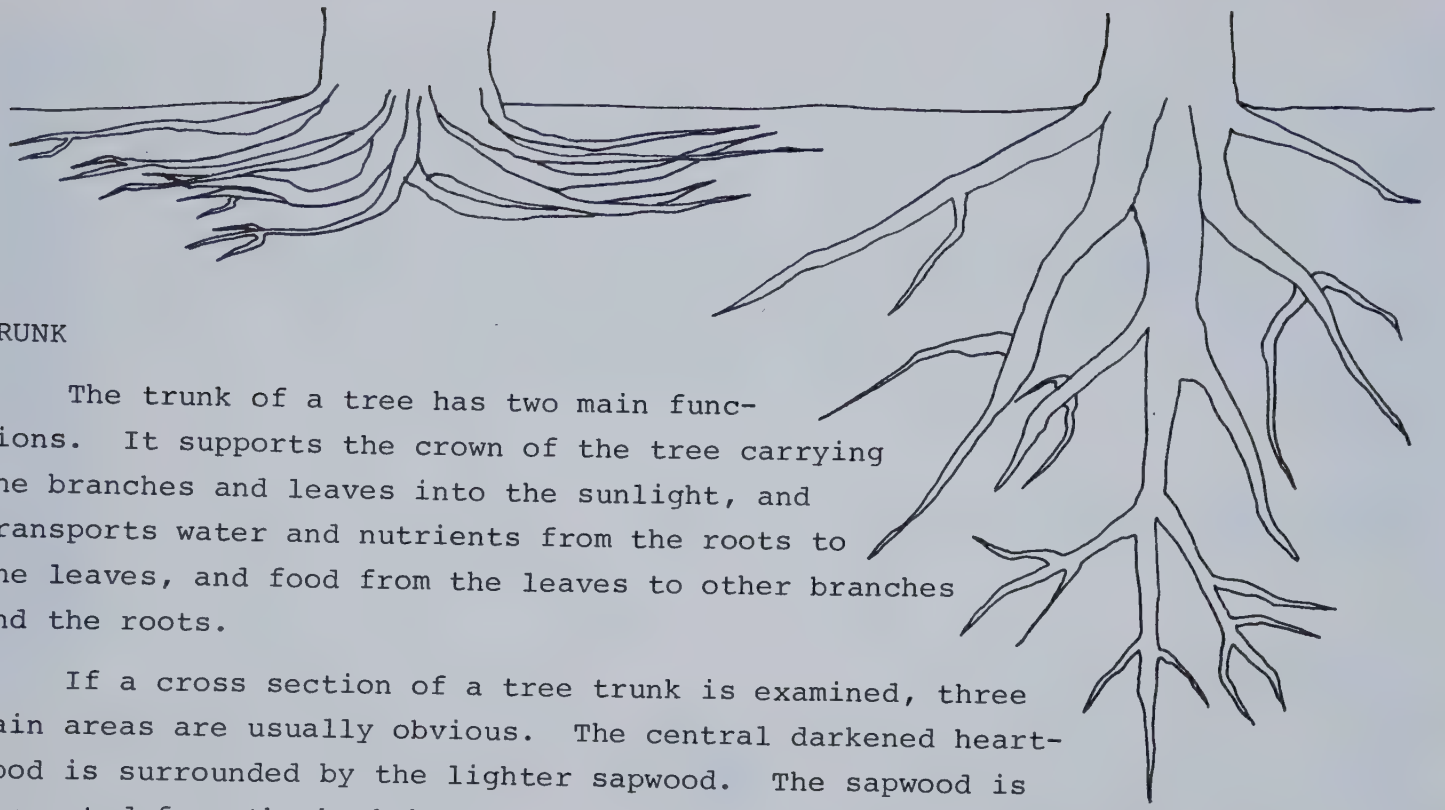
THE TREE AS A PLANT

A tree has an underground root system and a main stem or trunk, from which branches extend. These in turn produce leaves and eventually flowers, fruits, and seeds. The form and function of the parts making up a tree will be dealt with in this section.

Some Background Information

ROOTS

The roots are the underground branches of the tree. Their function is to anchor the tree firmly into the ground and to gather water and dissolved minerals from the soil and carry them to the main roots, the trunk and the rest of the tree. Some tree species have shallow roots spreading rather like a plate just beneath the soil's surface. Other trees have taproots which penetrate deeply into the soil. Obviously trees with shallow roots are more likely to be blown over by the wind that those with taproots.



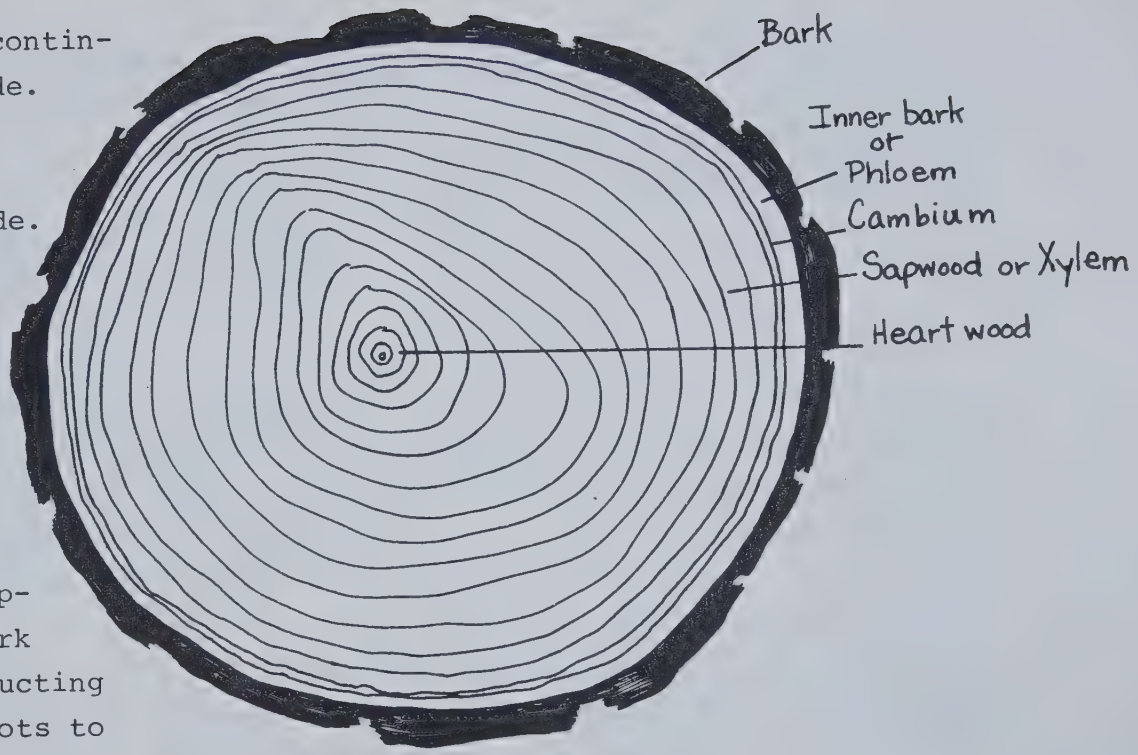
TRUNK

The trunk of a tree has two main functions. It supports the crown of the tree carrying the branches and leaves into the sunlight, and transports water and nutrients from the roots to the leaves, and food from the leaves to other branches and the roots.

If a cross section of a tree trunk is examined, three main areas are usually obvious. The central darkened heartwood is surrounded by the lighter sapwood. The sapwood is separated from the bark by a thin layer of cells, the cambium. Actually the cambium produces the bark on its outside and the sapwood on its inside. In this way, the sapwood is being continually added to on the outside. As the old sapwood in the centre of the tree ages and dies, it becomes heartwood. These dead cells are used to store the waste products of the tree. The wastes usually cause the heartwood to be darkened in color.

While the cambium adds cells to the sapwood, it also adds to the bark. But these cells are added on the inside of the bark. Thus the youngest cells are on the inside

of the bark and the oldest are continually being pushed to the outside. These old cells become terribly stretched as more sapwood and more bark are added on the inside. In some cases such as birch or cherry, the old bark is tightly stretched and in others, such as firs and maples, it breaks into ridges.



Aside from their obvious functions of providing strength and protection, the bark and sapwood serve as a transport network with the sapwood generally conducting water and nutrients from the roots to the rest of the plant, and the inner bark moving the food and other materials from one place to another in the tree.

ACTIVITY 9: EXAMINING A CROSS-SECTION OF A TWIG:

Materials needed: razor blades, slides, cover slips, microscopes, twigs of various trees

Using a single-edged razor blade, have pupils carefully cut thin sections from freshly cut twigs. For easier observation under the microscope, they should be so thin that the sections appear transparent.

Have the pupils identify bark cells, the cambium layer, and sapwood cells. If more than one year's growth can be observed, they will also be able to identify the large, rather thin walled cells of the spring wood and the tiny relatively thick walled cells of the summer wood. It is the sharp contrast between the summer wood and the next year's spring wood which produces the annual growth rings.

Leaves:

The leaves of trees, whether they are needle-like, scale-like or broad and flat as in the maple, all have the function of producing food and other substances. To make things, energy is needed. Our factories burn oil, gas, coal, or use electricity to provide the required energy. We are just beginning to learn how to use solar energy. Plants, on the other hand, are able to use solar energy directly and are able to store it in high energy chemicals such as sugars. Leaves do this by converting carbon dioxide and water into sugar using solar energy. The process, known as photosynthesis, is only now beginning to be understood by scientists. We have a lot to learn from plants!

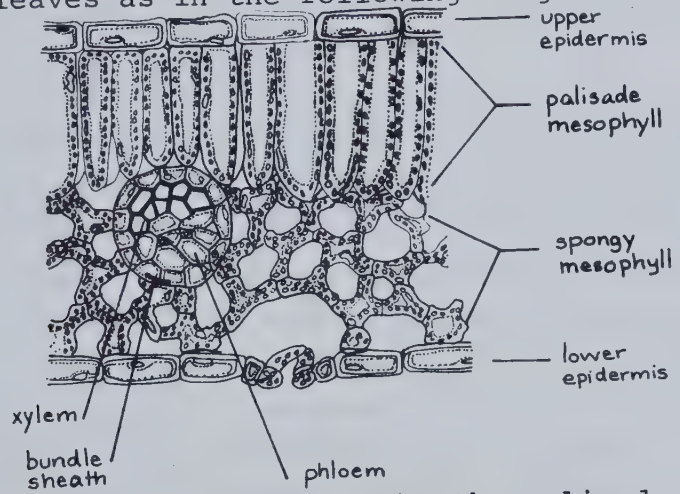
ACTIVITY 10: EXAMINING A CROSS-SECTION OF A LEAF:

Materials: single-edged razor blades, strips of polyfoam (used for packing), slides, cover slips, microscopes, needles and broad leaves from various trees.

1. Cut into a piece of packing-case polyfoam

2. Slip a piece of leaf or a needle into the cut

3. Carefully cut thin slices of the foam. Sections of the needles and leaves will also be produced.
4. Mount the cross sections in a drop of water on microscope slides and identify the parts of the leaves as in the following diagram:



Food manufacture is carried out mainly by the palisade cells and the spongy cells in the centre of the leaf. The epidermis cells provide protection and cut down water loss. The guard cells open and close the stomata (stoma, singular), allowing the exchange of gases which are used and produced during food manufacture.

ACTIVITY 11: STUDYING THE ROOTS OF A SEEDLING TREE:

Materials: shovel, magnifying glasses

Carefully dig up a seedling tree (no more than 20 centimetres tall). Shake the soil gently from the roots and if water is available, rinse the roots off very gently by dipping them into it and slowly swirling them about until the roots are clean.

Lay the seedling on a piece of white paper.

Some things to observe:

a. Examine the general structure of the root. Does it have a main root with branches or does it have a number of roots growing from the base of the stem as shown in the diagrams on page 16.

As a supplemental activity, you might have pupils compare the root system of a seedling tree with the roots of other kinds of small plants growing near it in the forest. Unfortunately children tend to ignore roots when they consider what a plant is. By emphasizing the importance of roots to the life of the plant you can help pupils gain new insights to plants and their component structures.

b. While the roots are still moist, examine the root tips for root hairs. These are so tiny that they must be examined with a magnifying glass. They are so fragile that most of them break off when the soil is shaken or washed off. With careful searching some root hairs may be observed. Can the seedlings be replanted? Are seedlings so abundant that each child has one?

Here are some questions for use in class discussion:

What differences are there where the plant changes from stem to root?
What advantages are gained by roots growing down?
What advantages are gained by roots growing sideways?
What is the function of bark on roots?
What do the roots do for the plant?

A Supporting Activity

For a better study of root hairs have the pupils germinate beans, peas or radishes between paper towels which are kept moist. After a week, examine a seedling for root hairs.

Trunk Studies:

ACTIVITY 12: COUNTING GROWTH RINGS:

Materials: sections of tree trunks or fresh stumps, magnifying glasses and a knife or 5 mm gouge. If possible, have sections of different kinds and ages of trees available for pupils to compare.

Using a magnifying glass, count the growth rings in a section cut from a tree trunk. If possible, have the pupils count the rings of a freshly cut stump in the forest. If the rings are obscured by saw marks, use a knife, or better still, a 5 mm gouge to cut a smooth channel from the bark to the centre of the tree. Where the tree has grown rapidly, the rings can be counted without the aid of a magnifier, but there are usually a few years when growth has been limited and the rings extremely fine.

Here are some questions which can be answered:

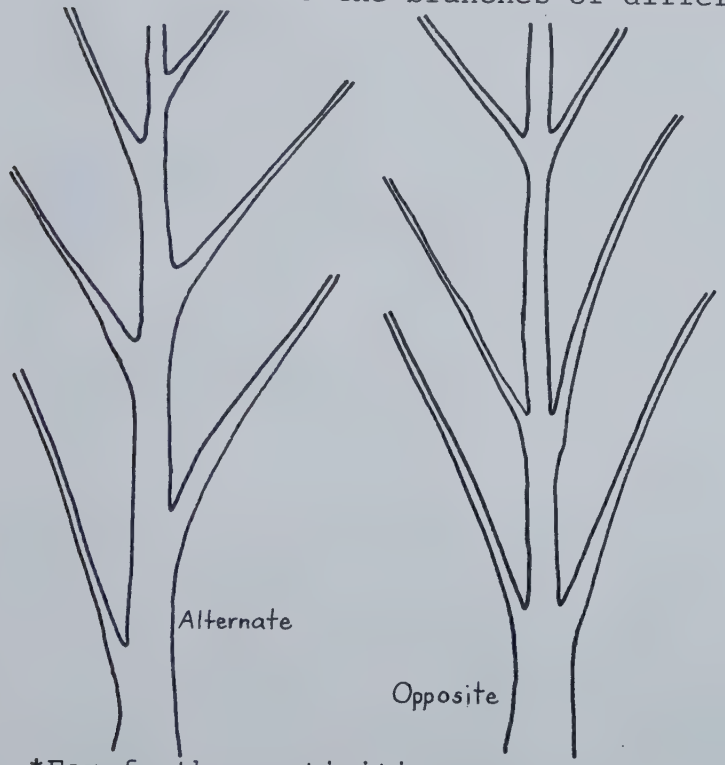
How old is the section or stump which you have counted?
How old was the section or stump in the year it grew the fastest?
How old was the section or stump the year it grew the slowest?
How much growth was added the year you were born?
Which parts of the section or stump are the youngest?
Which parts of the section or stump are the oldest?

Compare a freshly cut stump with one that has decayed and been overgrown. What parts of the stump decay first? In an old rotting stump, are the growth rings still visible?*

ACTIVITY 13: STUDYING BRANCHES:

Examine the branches of different kinds of trees. Do the branches of your tree grow mostly upwards or outwards? Are there any trees with branches hanging down? Which trees do you think could best stand a heavy snowfall?

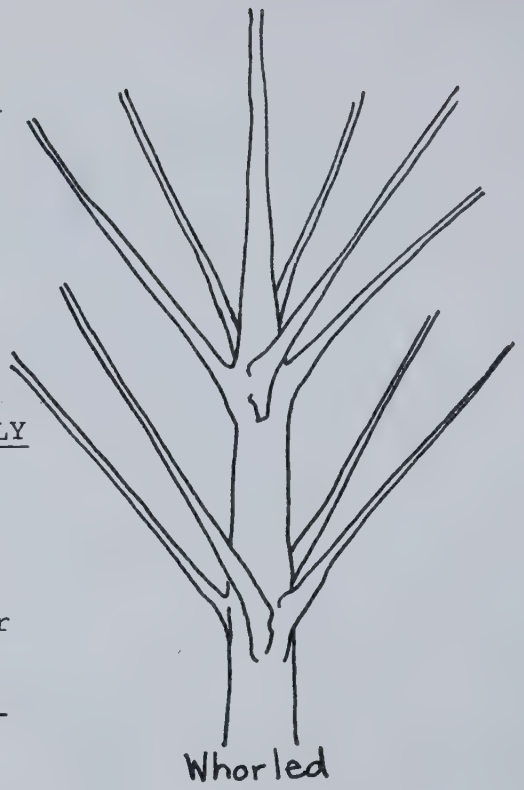
Draw the silhouettes of different kinds of trees.



*For further activities on stumps, see The Stump Book , Western Education Development Group, U.B.C., 1975.

Examine the arrangements of the branches of your tree. Are they arranged in a special pattern i.e. alternate, opposite or whorled?

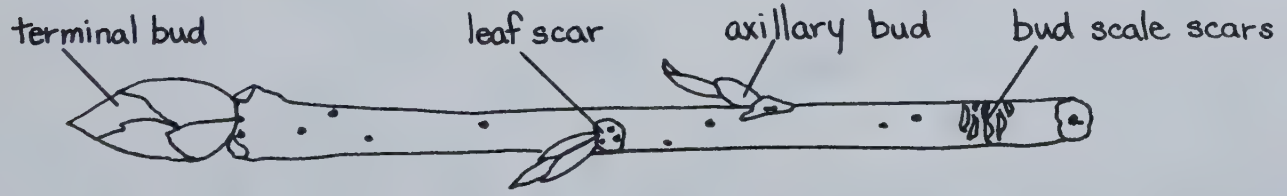
How many branches are on your tree? Where are the longest branches, the shortest, the youngest and the oldest? What can you find at the end of the tree's branches (buds, leaves, flowers, seeds)?



ACTIVITY 14: STUDYING TWIGS - AN EXCELLENT WINTER AND EARLY SPRING ACTIVITY

Materials: Some twigs with large buds such as poplar or horse chestnut, magnifying glasses.

Examine the twigs and look for buds.* Note their arrangement and shape. Are they in pairs, opposite one another, or do they alternate as in the accompanying diagram?



Look for the scars which are left behind when leaves fall off. Notice that every leaf scar has a bud next to it. On which side is the bud, toward the base, toward the tip or on the side of the scar? Which buds are the largest, the ones at the tip (terminal buds) or those on the side of the twig (axiliary buds)?

---

*An excellent reference is T.W. Thomson's Common Trees and their Buds, Audubon Nature Bulletin, New York, 1964.

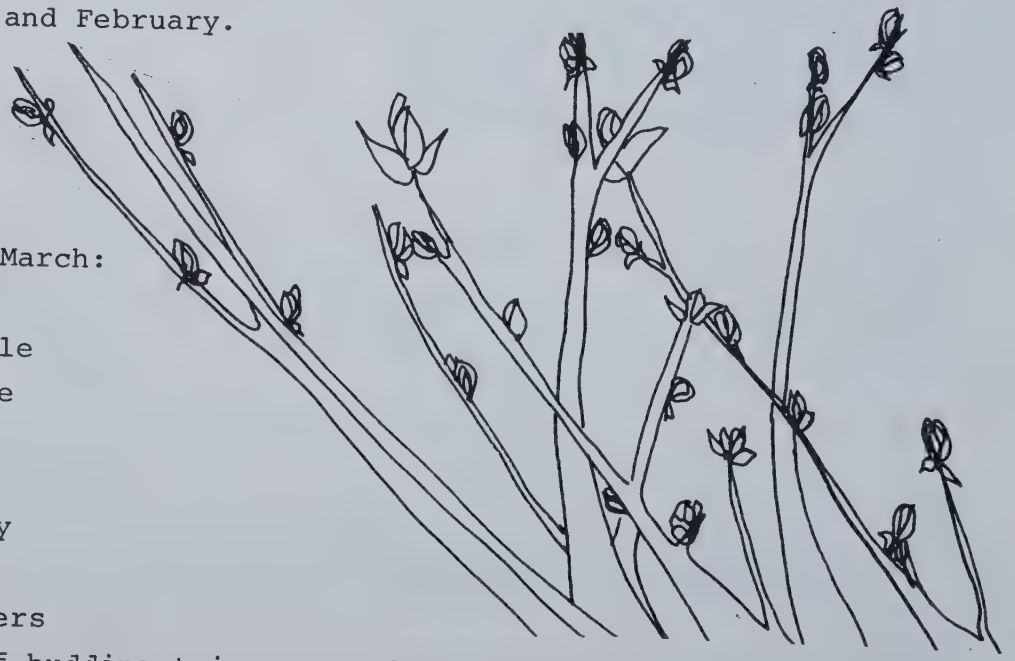
Are the buds on your twig naked or are they covered with scales? If they are covered, look for the scars from the previous year's terminal bud scales. That tells you how much growth has taken place in one year. How many centimeters did your twig grow in one year?

ACTIVITY 15: BUDDING WINTER TWIGS:

The study of branches and an understanding of how they develop their leaves in the spring can be an exciting exercise when the branches of broadleafed trees and shrubs are brought into the classroom just before they leaf out in the spring.

Branches 30-40 cm long are ideal for the activity. The more buds they bear, the better. The following trees and shrubs make excellent budding twigs for study in January and February.

- Elderberry
- Hazelnut
- Spirea
- Waxberry



In late February and March:

- Red alder
- Big leaf maple
- Douglas maple
- Vine maple
- Willow
- Bitter cherry
- Crab apple

and many others

* For further study of budding twigs, see the E.S.S. unit Budding Twigs , McGraw Hill, 1970.

The cuttings will leaf better if:

a) they are cut with a sharp knife

b) they are taken directly to the classroom and put in water

c) the bases are re-cut under water once they are brought into the classroom.

An air lock is often formed in the water conducting tubes resulting in insufficient water for full leafing out. If these air locks are cut off under water, better leafing out is often achieved.

d) they are covered with a plastic bag

e) they are <u>not</u> placed above a heat outlet

Some activities:

a) Try putting some outside the classroom window and some inside. Make sure both have sufficient water.

b) Try putting some in water and some in a container without water.

c) Try putting some in a refrigerator and some in the classroom. Make sure both have sufficient water.

d) Try putting some in the dark and some in the light.

ACTIVITY 16: <u>BRANCH PUZZLES</u>:

Branch puzzles are simply branches which are cut up with a jigsaw. In order to put them back together, the children have to look very carefully at them. Try cutting branches of two or three different kinds of trees. When they get to be experts mix up the different kinds. They will soon learn to distinguish the barks of different species.

As a follow-up, have the children find some similar branches which are still attached to their trees.

Bark Studies:

ACTIVITY 17: MAKING BARK RUBBINGS:

Materials: paper; wax crayons, charcoal, or soft pencils; candle wax and poster paints.

Bark rubbings can be made by pinning or taping paper to a tree and rubbing with a crayon, charcoal, or a soft pencil.

Rubbings from different kinds of trees can be compared. Bark rubbings can help children identify trees because each different tree type produces a distinctively different pattern.

This activity can be used as an art experience as well as a study in bark anatomy and classification.

For an interesting variation of the technique, colorless candle wax can be used. When the rubbing is completed, the sheet of paper is brushed over with poster paint to produce a negative picture of the bark. In this way, the gaps between the ridges are emphasized instead of the ridges themselves.

ACTIVITY 18: EXAMINATION OF BARK:

Materials: Metre stick, bark rubbing materials.

Encourage the pupils to examine and compare the bark of about five different types of trees.

Some questions for investigation:

What kind of tree is it?
What color is the bark?
Is the bark rough or smooth?
How wide are the gaps between the ridges?
How thick is the bark?

These questions can be dealt with in a chart as follows:

Kind of tree	Bark rubbings	Color of bark	Texture	Width of cracks

Here are some questions to use in class discussion:

Do all cracks have the same width?

Do the cracks run horizontally or vertically or both?

How does the bark differ on opposite sides of the tree?

How does the bark differ at various heights of the trunk?

How does the bark on an old tree differ from the bark on a young tree of the same species?

What is the shape of the breathing holes (lenticels) on the bark?

How do their sizes vary?

How many different mosses or lichens are on the bark of your tree? Describe them.

How is the carving of initials in the trunk injurious to the tree?

Why does girdling of a tree (stripping the bark off in a ring that goes all around the trunk) usually kill the tree?

In what natural ways can a tree become girdled?

ACTIVITY 19: EXAMINING THE BARK AS A HOME FOR OTHER PLANTS:

Materials: chalk, compass, lightmeter, thermometer, ruler.

Lay out at a height of approximately 1 1/2 m. bark plots 15 cm square

on the north, south, east and west side of a big tree trunk. Outline the 4 squares with chalk. Examine the bark for lichens and mosses. Are there plants growing in each square? Count the number of plants in each square or estimate the percentage of the bark area covered by plants. Measure the light and temperature in each plot. Table your results.

Kind of tree	Side of tree	No. of plants or % area covered	Amount of light	Temperature

Questions for discussion:

Do some squares have more plants than others? If so, why?

Which side is the coolest? The hottest?

Which side gets the least light? The most light?

Which side of the tree do you think gets the most moisture?

Do certain kinds of moss or lichens prefer certain species of trees?

Do they harm the tree? How can you tell?

A note about Lichens:

Lichens are a double plant consisting of a partnership between a fungus and an alga.

Lichens can withstand long periods without water and are therefore well adapted to survival on bare rock surfaces, as well as on the tree's trunk and branches. They can resist intense heat but need pure air to survive. Lichens are seldom found on trees in cities, since they are very sensitive to air pollution.

ACTIVITY 20: INSECTS AND TREES:

Materials: bed sheet, magnifying glass, small plastic containers.

Look for insects on buds, leaves, flowers and the trunks of trees. Also try searching in the wood and bark of dead trees. To collect insects, spread a white sheet under a tree branch and then shake the branch. Collect the insects in plastic containers and examine them with a magnifying glass. Some questions for discussion:

Do you find the same kind of insects on different parts of the tree? Levels of the tree? Describe them.

What do you think attracts them?

How could they hurt the tree?

How do your insects move about?

Which insects are camouflaged so that they look like part of the tree?

Which insects are brightly colored? Do they stand out against the tree? How would the bright color help the insect?

Design and draw an insect that could successfully live on a tree. State the type of tree, the insect's shape, the size and coloration. Show the design to other members of the class and discuss why the insect would be overlooked by insect hunting birds.

ACTIVITY 21: INJURED, DYING, OR DEAD TREES*:

Children are fascinated by disease in trees. If you can find a diseased tree, its study will provide a very involving and rewarding activity for your pupils.

Here are some signs of disease:

1. Dead or dying branches at the very top of the tree. This often means that the roots are diseased and cannot provide water for the top of the tree.
2. The presence of mushrooms, bracket fungi or other fungi growing out of the bark, roots, or branches. These are the reproductive structures of fungus plants which are feeding on the wood inside the tree. Actually, what you see on the outside of the tree is only a small part of the plant, which may be rotting the tree five or six feet above and below the reproductive structure.
3. Massive numbers of cones or fruits. This is often referred to as a "distress crop". Somehow, the plant senses that death is approaching. It reacts automatically by producing an enormous seed crop.
4. General yellowing of leaves or needles.
5. Production of distinctly smaller leaves or needles compared to surrounding trees.
6. The production of a large number of branchlets from a single location on a branch. This is called a "witches broom". It is typical of misteltoe diseases.
7. Woodpecker holes in living trees indicate that the tree is infested with insects which are feeding in the wood or under the bark. Woodpeckers can hear the movements and feeding noises of insects. They then chop into the tree with their axe-like beaks to feed. They never dig "exploratory holes"!

*See The Stump Book, Western Education Development Group, University of B.C., 1975.

Tree Trouble Data Sheet

Check the parts of the tree which are involved: needles _____ leaves _____

lower branches _____ tip branches _____ middle branches _____

lower main trunk _____ middle main trunk _____

tip main stem _____.

What are the symptoms:

Injuries: broken branches _____ gnawed bark _____

broken bark _____

Disease: tip die back _____ yellowing _____

small leaves or needles _____ sap oozing out of bark _____

distress crop of cones or fruit _____ witches broom _____

insect holes _____ mushrooms from trunk or branches _____

woodpecker holes _____ loose bark _____

mushrooms from roots _____ bracket fungi on main trunk _____

bracket fungi on branches _____ bracket fungi on roots _____

mistletoe plants _____

General conclusion about tree trouble _____

_____

_____

ACTIVITY 22: CLASSIFYING LEAVES:

Examine the type and arrangement of leaves on different trees. Are the leaves broad or needle-like? How are they attached to the branch? Are they stalked? Is the stalk long or short? What color are the leaves? Are the leaves dark or light in color? Are the leaves simple or compound?

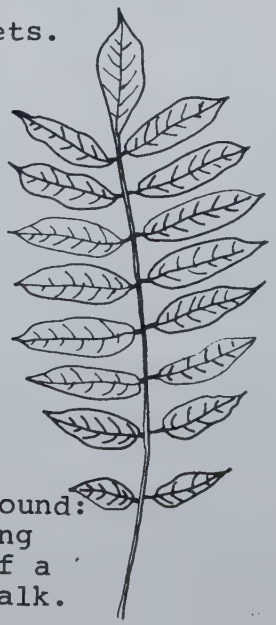
Describe the margins, vein arrangement, shape, etc.

Where are most of the leaves on your tree? Are they close to the trunk or at the tips of the branches? Is there a difference between the upper and the lower sides of the leaves? Is there a difference in color or texture? Is the leaf curled? Is it curled back at the tip? Are the leaf sides curled in?

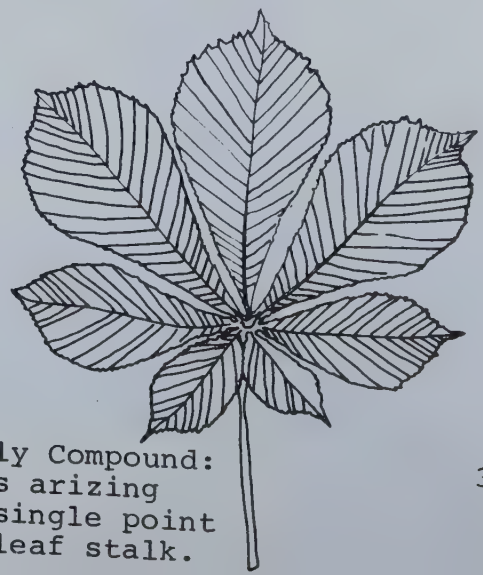
Simple and Compound Leaves:

Most leaves have a single blade arizing from the supporting branch. This leaf type always has a bud at its base as is shown in the diagram. These leaves are called simple leaves. Some leaves, however, have been divided into a series of leaflets. These leaves are called compound leaves. Compound leaves always have a bud where they join the supporting branch but never have buds at the bases of their leaflets.

Simple Leaf
note bud at base



Pinnately Compound:
leaflets arizing
on each side of a
single leaf stalk.



Palmately Compound:
leaflets arizing
from a single point
on the leaf stalk.

Leaf Margins:

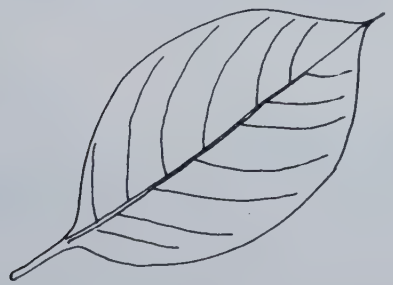
Entire:

Lobed:

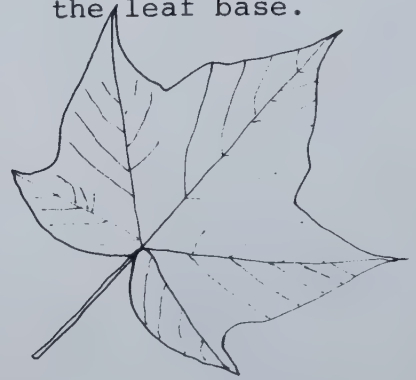
Toothed:

Vein Arrangement:

Pinnate veins lead off a single main vein like a feather.



Palmate: several veins lead from the leaf base.

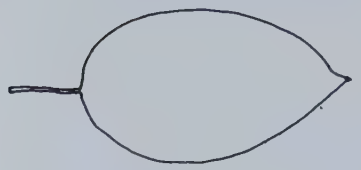


Leaf Shapes:

Palmate

Cordate or heart shaped

Ovate or oval



Lanceolate or lance shaped

Linear or long and thin as in grass

NEEDLES:

The leaves of cone-bearing trees are needle-like. Needles also have distinguishing features:

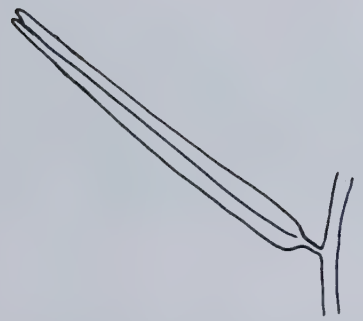
Sharp

Blunt

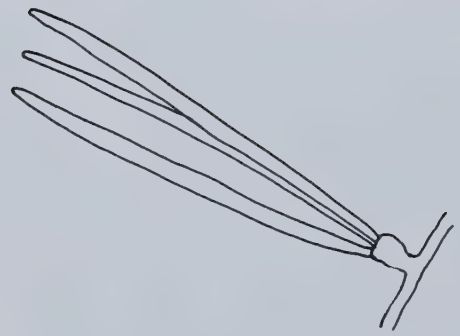
Notched

Arrangements:

single



in bundles



Flattened:
needles form two rows

bottle brush:
needles more or less evenly distributed around the branchlet

ACTIVITY 23: STUDYING LEAF VEINS BY MAKING LEAF SKELETONS:

Materials needed: hair brush, small piece of thick cloth or felt (about 20 cm square), microscope and hand lenses.

Leaf veins can be studied in the intact leaves but pupils find it more interesting and much easier if the soft parts of the leaf are removed. What is left behind is the network of veins which supply the leaves with water and nutrients and move manufactured food and waste products to other parts of the plant. There are two ways of preparing leaf skeletons.

a) By the hairbrush method:

Place a leaf on a piece of cloth or soft felt. Tap the leaf repeatedly with the brush until the soft parts break away leaving the veins behind. This method works with leaves such as maple and alder but, depending on the force used, much of the vein structure is torn out with the soft leaf tissue. With patience a good leaf skeleton can be produced.

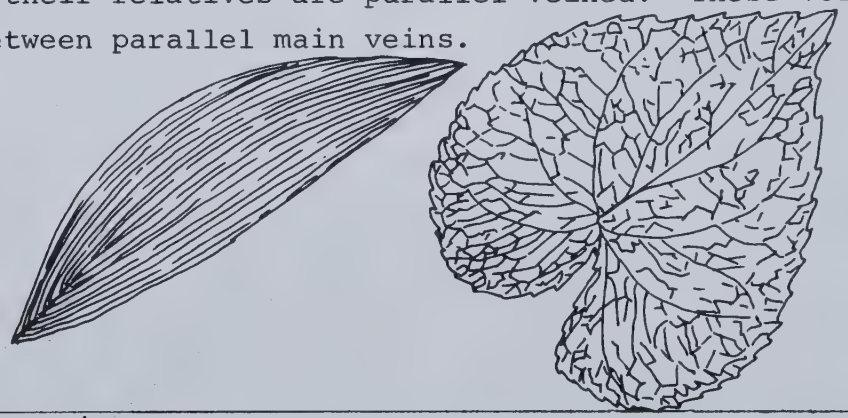
b) By bacterial and fungus action:

Suspend the leaves in a jar of water and let it stand in a warm spot for a period of time. You need patience for this activity, because it usually takes a month or two for the leaves to become completely skeletonized. This method works well with finely veined

leaves such as grass and the delicately structured leaves of ornamental flowers along with those which are more sturdily structured.

For Your Information

There are basically two types of venation in leaves. Most leaves are net veined where the veins form an irregular network from branching major veins. Grasses and their relatives are parallel veined. These veins form cross connections between parallel main veins.



Some questions to investigate:

Does your leaf have net or parallel venation?
What is the greatest distance between veins?
Are all the veins of the same thickness?
Which veins are the sturdiest?
What color are veins in fresh leaves?

ACTIVITY 24: ESTIMATING THE NUMBER OF LEAVES ON A TREE:

Select an average sized branch on a tree. Count the number of leaves on it. Now count the number of branches of the same general size which are on the tree. Multiply the number of leaves on one branch by the number of branches on the tree.

e.g. No. of leaves on 1 major branch = 93

No. of major branches on the tree = 14

Thus the number of leaves on the whole tree is approximately:

93 x 14 = 1302 leaves

ACTIVITY 25: LEAF MOVEMENT STUDY:

Material needed: string

You can begin this activity by challenging the pupils to try to discover if leaves are capable of movement. The children will easily observe that there is a "top" side and an "under" side to leaves. If you tied a branch so that the underside of the leaves are facing up, will the leaves turn themselves over? Try tying a branch and then observe it each day for several days.

ACTIVITY 26: A STUDY OF WATER LOSS THROUGH LEAVES (TRANSPIRATION):

Materials required: A well sealed plastic bag, string, cellophane tape.

Children will gain an insight to the enormous amount of water which trees lose through their leaves by carrying out this study. To study water loss from a single branch, place a water-proof plastic bag over a branch so that at least five leaves are inside of it. Tie the bag tightly to the branch with string. Then, to be extra careful that water does not escape the bag, tape the bag edges with cellophane or electrician's tape until they are well sealed to the branch.

Examine the bag each day for several days. You may wish to weigh or measure the volume of water accumulating in the bag.

What would happen if you put another bag on a similar branch which has had its leaves removed? Would you obtain the same results?

ACTIVITY 27: ART WITH LEAVES:

1. Leaf Printing:

   Some very interesting designs can be made by leaf printing. Ink or paint the undersides of several types of leaves. Then place the leaves on top of the paper to be printed. Put a sheet of scrap paper such as newspaper, over the top of the leaves and roll or rub the surface until a print is made.*

2. Leaf Rubbings:

   A leaf rubbing can be made by laying a piece of paper over a leaf. Lightly rub the paper with charcoal, crayon or soft pencil.

3. A Leaf Collage:

   As every teacher knows, excellent collages can be made by glueing fallen leaves on paper to make a pattern. Unfortunately, the leaves usually shrivel up after a day or so. To avoid this, press the leaves in an old book before the collage is made. (Iron gently (low heat) between wax paper, then press to dry.)

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*The cover of Meet the Natives a VEEP unit on the B.C. Native Garden on the campus of U.B.C. is a design of leaf prints.

ACTIVITY 28: BROAD LEAFED AND NEEDLE LEAFED TREES:

Forest trees can be divided into two major groups, broad leafed and needle leafed trees. Broad leafed trees usually lose their leaves in autumn, and for this reason are often referred to as deciduous. Needle leafed trees, on the other hand, usually keep their leaves for periods of up to eight years. The leaves remain on the tree in the winter, and for this reason are often referred to as evergreen. The wood of broad leafed trees is usually very compact and is therefore referred to as hardwood. The less compact, and often faster growing wood of evergreens is referred to as softwood.

Thus the following generally holds true:

BROAD LEAFED TREES = DECIDUOUS = HARDWOOD = FLOWERING TREES
NEEDLE LEAFED TREES = EVERGREEN = SOFTWOOD = CONE BEARING TREES

Activities to teach children to distinguish between broad leafed and needle leafed trees should begin on the school grounds. A walk around the school to identify which trees are needle leafed and which are broad leafed will help your students to a better understanding of the trees in their own community. They should be encouraged to look for evidence of cones and flowers. It also provides an excellent preparatory activity for the study of our forest broad leafed and needle leafed trees.

Some questions which can be asked:

Which trees tend to grow taller?
Which trees tend to grow wider?
Which trees have the most leaves?
Which trees have the largest leaves?

Which trees allow the most light to reach the ground?

Would spring flowers grow best in an evergreen or a deciduous forest? What would make the difference?

Are deciduous trees alive during the winter? How could you tell? The teacher or the pupils might suggest cutting twigs to carry out the budding twigs activity (see page 24). There are many other activities which children may suggest such as examination of bark and buds under the microscope. One class made a large plastic tent to put over a tree and converted it into a greenhouse with a portable oil heater. They made the big plastic bag by ironing clear plastic sheeting together. To keep it from floating away, they pinned it down with tent pegs tied through the rolled bottom edge. If you try this, be careful not to raise the temperature above that of a cool summer day (18-20° C). Remember, the ground may be so frozen that the roots and ground water may need to be thawed. It makes an interesting and challenging activity for students.*

ACTIVITY 29: THE FLOWERS OF BROAD LEAFED TREES:

Materials: hand lenses

Most children are not aware of the flowers of the common broad leafed trees which are found around our schools and in our forests. An exception is the dogwood; though strangely enough, the white structures which are recognized as petals are simply special leaves which surround the mass of tiny green flowers in the middle. Thus, even the dogwood has rather inconspicuous flowers displayed by very conspicuous leaves.

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*Please note that if the tree is refrozen after this activity, it can be killed (depending on how cold it gets). Thus, once the experiment is begun, the tent should remain on the tree until spring. Solar heat should provide most of the energy.

Many broad leafed trees bear unisexual flowers. This means that some of the flowers bear only pollen and cannot produce fruits and seeds. Others receive the pollen and produce fruits and seeds but don't bear stamens or produce pollen.

Examples of trees with unisexual flowers are alder, hazelnut, and willow. These produce long clusters of pollen bearing flowers called catkins. The "female" flowers (those which produce seed) of alder and willow are produced on shorter catkins than the male flowers. "Pussy willows" are the catkins of our willows. The female flowers of hazel are individual or in pairs, and are pink or red in color. Male hazelnut catkins are long and pendulous.

Maple flowers hang in long pendulous clusters but each greenish yellow flower is recognizable.

Timetable for collecting broad leafed tree flowers:

January - February - Hazelnut
February - March - Alder
March - April - Maple, cherry, crabapple and dogwood

Most boulevard trees flower from late April to mid-June. Other than the showy cherries, plums, and horse chestnuts, they produce greenish and usually quite small flowers.

Collect the flowers of three or four species of trees and encourage the children to look at them with magnifying glasses. Encourage them to look for pollen sacs, petals, sepals and stigmata. Then take them outside to discover which trees the flowers came from.

The following chart may be of some help:

Description of Tree	Shape of Flower	No. Of Sepals	No. of Petals	Petal Color	No. of Stamens	Other Characteristics

Do all flowers have petals? Can you find flowers which have either no stamens or no pistil? Do some trees get their flowers before they get leaves? Why?

If children or you, the teacher, wish to identify the trees of our forests, an excellent book on our native trees is:
HOSIE R.C., Native Trees of Canada, Queens Printer for Canada, Ottawa, 1969.
In B.C., use the Tree Book , produced by the B.C. Forest Service, Victoria, B.C. 1977.

If you wish to identify the boulevard trees, a good book which describes 800 varieties of trees is:
MITCHELL, Alan, The Trees of Britain and Northern Europe. Collins, London 1974.

ACTIVITY 30: MAKING A POLLEN COUNT - A SPRING ACTIVITY:

Materials: Microscopes, paper, a small pill bottle, cherry, plum or other trees in flower.

For this activity, choose a small tree and locate some pollen bearing flowers. Shake the branch to observe the clouds of pollen produced. Then find another branch with pollen bearing flowers. Pick off one flower and shake the pollen on to some paper. Try to catch all of the pollen on the paper by carefully tapping the flower very close to the paper. When you have as much pollen as possible on the paper, carefully tap the pollen to the centre and pour the pollen into a small vial.

With this sample, you can estimate the number of pollen grains produced by the tree. Because of the amount of pollen lost to the wind, your estimate will be quite low but it will be impressive.

How can you make your estimate? This is an excellent question to propose to the class. We have had some ingenious methods of estimating proposed.

1. Smear some vaseline on a sheet of glass on which only one half cm square has been drawn. Sprinkle the pollen as evenly as possible over the sheet of glass. With a microscope, count only the pollen on the marked half square cm with a microscope. Multiply by the number of half square centimeters contained by the whole sheet of glass. If there are still too many pollen grains to count, you can use a bigger sheet of glass!

Here is an example:

a) If the glass is 10 cm^2, it contains 400 one half square centimeters.

b) If you have counted 117 pollen grains in your half square centimeter, then the approximate number of pollen grains in your sample is 44,700.

Now you have some idea of the number of pollen grains produced by a single flower. The pupils can easily estimate the number of flowers on the tree to provide a rather staggering estimate of the amount of pollen produced by a whole tree.

The tree from which we took our flower was estimated to have 36,000 flowers on it (by counting one branch and multiplying by the number of branches on the tree).

In this way, we estimated that by tapping all the flowers we would probably find our tree produced about 36,000 x 44,700 = 1,609,200,000 pollen grains.

ACTIVITY 31: GERMINATING POLLEN GRAINS:

Materials: Water, table sugar, fresh pollen and a microscope

Pollen grains can be germinated by placing them in a sugar solution made by dissolving a teaspoon of sugar in a cup of water. Try a number of different kinds of flowers since variety and maturity affect the ability of pollen to germinate.

Examine the pollen grains under a microscope after one, two, and three days.

Fruits and Seeds:

All flowering trees produce fruit. Inside the fruit is its seed. Very often the seed is fused inside the fruit and cannot easily be separated. The winged fruit of the maple is an example. Most people call it the maple seed, and so it is. But what you see is the fruit; the seed is inside.

Distinguishing fruit from seed is a very exacting task. Even experienced botanists have difficulties at times, and very careful developmental studies are often necessary to distinguish between what is fruit and what is seed. Thus, for the elementary school level, it is better to let the pupils decide for themselves. The rule of thumb is:

> What you can see without cutting it open is fruit. Smaller round structures which can be shaken out of the fruit or can be observed by cutting open the fruit are seeds. The seeds of flowering plants are never produced nakedly on a branch.

ACTIVITY 32: STUDYING FRUITS:

Collect three or four different kinds of wild fruit such as mountain ash berries, winged maple fruit, alder catkins, hazel nuts, crab apples etc.

Have the pupils disect them to discover their seeds. If you have collected the fruit, take the class to where you got them and have them identify the parent trees.

ACTIVITY 33: GROWING TREES FROM SEED:

Materials: Soil, milk cartons or plastic cups for pots, various tree seeds.

Trees such as maple, alder and wild cherry can be grown from seed. The seeds, however, are often very slow to germinate. It is worth trying, and the results are usually very exciting for children.

Encourage the children to collect seeds from as many trees as they can find.* Include boulevard trees such as horse chestnut, elm, ash. Other forest trees (besides those listed above) which can be grown are birch, mountain ash, aspen, and cottonwood.

You will find that a rich potting soil will give the best results. Each container should be labelled with the type of seed it contains. Depending on the size of container and the dryness of the room, the pots should be watered two or three times a week.

Some, but not all of the seeds will germinate.

ACTIVITY 34: LOOKING AT THE CONES OF NEEDLE LEAFED TREES:

Have the students collect as many different kinds of cones as they can. Each type of cone has characteristics of its own. Challenge the pupils to sort the cones they have collected into the various types.

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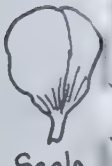
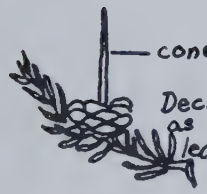
*If your class wishes to grow the seeds of cone bearing trees, see the VEEP booklet Forest Nursery Studies , Western Education Development Group, 1975.

KEY TO FEMALE CONES



CONES WITH DECIDUOUS SCALES
TRUE FIRS

CONES WITH NON-DECIDUOUS SCALES



Deciduous scales fall off as soon as cone reaches maturity, leaving a central spike, the cone axis.

BRACTS NOT OBVIOUS OR LACKING

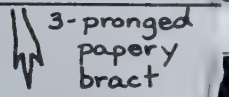
CONES WITH OBVIOUS BRACTS; OR BRACTS SOMETIMES OBVIOUS ONLY AT BASES OF CONES

CONES 3 cm OR LESS LONG

CONES MORE THAN 3 cm LONG

CONES WITH THIN, ALMOST HAIRLIKE BRACTS
LARCHES

CONES WITH 3-PRONGED, PAPERY BRACTS
DOUGLAS-FIR



CONES WITH LESS THAN 18 SCALES

CONES WITH 18 OR MORE SCALES

CONES WITH PAPERY SCALES, OFTEN WRINKLED AND RAGGED AT EDGES
SPRUCES

CONES WITH RIGID, WOODY SCALES
PINES

CONE-SCALES OPEN WIDELY WHEN MATURE
WESTERN HEMLOCK

CONE-SCALES OPEN ONLY SLIGHTLY WHEN MATURE
BLACK SPRUCE

CONES WITH 9-10 SCALES
WESTERN RED CEDAR

CONES WITH 4-6 THICK SCALES UMBRELLA-SHAPED, OPPOSITE ARRANGEMENT
YELLOW CEDAR

If this activity is carried out in the forest, you can ask them to find an example of a tree producing each type of cone. You can encourage the pupils to make up their own names for the trees and then discuss why they decided on those particular names. If you have a very imaginative class, each tree will have been given a number of names by different pupils. This provides you with an excellent opportunity to discuss why a single name for a tree is decided upon by scientists.

The accompanying key to the common cones will help the pupils find the most common name for many western species of cone bearing trees. If your trees are different, perhaps your class can make up its own key to the kinds of cones they have found.

Some additional ideas to follow up:

1. Do a tree weather study. Compare the weather under or in a tree to the weather away from the tree.

2. Adopt a tree on the school grounds or in the neighbourhood and keep a weekly diary on it.

3. Investigate how native people used trees for clothing, utensils, building materials, religious articles, and ornaments.

4. Try growing trees by vegetative propagation. You can try rooting willow cuttings to begin with.

5. Estimate the weight of a tree by weighing a small part of it, such as a branch.

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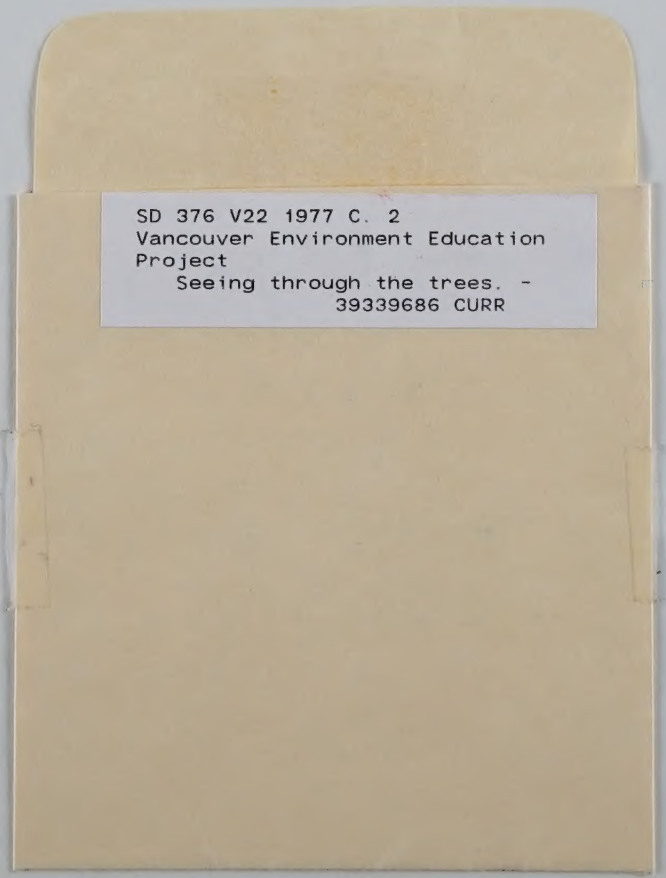
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